Acoustic testing at wind tunnel facilities of German-Dutch Wind Tunnels (DNW)
Contents

- DNW organization
  - Sites & facilities
  - Customers
- DNW Large Low speed Facility LLF
  - Initial design
  - Acoustic upgrades
- Key test capabilities & measurement techniques
  - Measurement techniques
  - Test capabilities
- Conclusions
1) Amsterdam The Netherlands
2) Marknesse The Netherlands
3) Braunschweig Germany
4) Göttingen Germany
5) Köln Germany
DNW wind tunnel facilities

- Subsonic, ...
- transonic ...
- ... and supersonic wind tunnels

- Testing for industrial customers: LLF & HST
- Non-aeronautical tests: LST
- DLR R&D wind tunnel tests: NWB, KKK, TWG, HDG, KRG, RWG
Global customer base

DNW customers around the world

- CANADA
- USA
- ENGLAND
- EU BRUSSELS
- FRANCE
- SPAIN
- GERMANY
- NETHERLANDS
- ITALY
- TURKEY
- ISRAEL
- JAPAN
- SOUTH KOREA
- CHINA

DNW

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DNW-LLF original background noise level design target

- Early 70ties initial background noise design point based on Fokker F-28 Mk 1000 (take-off side-line noise level at 500 ft)
- Aim for 95 EPNdB to account for future more stringent A/C noise requirements
- DNW-LLF design phase target set to 73 dB (1/3 octave band @ 1kHz, 80 m/s, 15 m tunnel side line)

Acoustic upgrade of LLF

Reduction of background noise:

- 2010: Modification of Nozzle and Collector (minor noise sources)
- 2011: Acoustic lining of turning corners 2 & 3 (up to 6 dB reduction)
- 2014: Upgrade of Heat Exchanger – Flow Straightener (analysis ongoing...)
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Acoustic measurement techniques @ DNW

- Traversing mechanism (60 GRAS ½” free-field condenser microphone, type 40AC)
- 160 Far field microphones installed on walls, floor & ceiling (LinearX M51 type)
- 2 Out-of-flow acoustic microphone arrays (4*4m, 142 M51 free-field microphones each)
- 2 Wall installed acoustic arrays (1*1m)
- 5+4 GBM Viper systems (48 channel) data acquisition systems
Typical aircraft noise testing setup in OTS
External noise: acoustic testing

Anechoic lining for reflection absorption

Out-of-flow microphone traversing system

Acoustic array
Open rotor (noise) testing
Full-scale A340 main landing gear

Fly-over-line-view array

Sideline-view array
Helicopter model with main- & tail rotor

Inflow Wing

Microphone array
Wind turbine in DNW-LLF

Noise sources identification in rotor plane

Noise sources identification for individual rotor blades
Wall array and A340 1:10 model

0.5x0.5 m²

Wall Array
Various
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Conclusions

- DNW facilities are used extensively for aircraft testing by European and non-EU industries.

- Versatile technologies as part of wind tunnel infrastructure, with focus on aircraft noise (engine integration & ground effect).

- Additional strength through availability of technology and analysis capabilities from parent institutes DLR and NLR.